THE U.S. NUCLEAR REGULATORY COMMISSION OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S KEY TECHNICAL ISSUES AGREEMENT RESPONSES RELATED TO THE POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA: RADIONUCLIDE TRANSPORT (RT) 3.01 AND 3.04; TOTAL SYSTEM PERFORMANCE ASSESSMENT AND INTEGRATION (TSPAI) 3.28 AND 3.29; AND THERMAL EFFECTS ON FLOW (TEF) 2.10, 2.11, 2.12, AND 2.13

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue resolution goal during the pre-licensing period is to ensure the U.S. Department of Energy (DOE) has assembled sufficient information on a given issue for NRC to accept a potential License Application for review. It is important to note that resolution of an issue by NRC during the pre-licensing period does not prejudge the NRC staff evaluation of the issue during the licensing review. Issues are resolved by the NRC staff during pre-licensing when the staff have no further questions or comments about how DOE is addressing an issue. Pertinent new information could raise new questions or comments on a previously resolved issue. The NRC licensing decision will be based on information provided as part of a potential License Application.

This enclosure contains NRC staff's comments concerning DOE's responses to the following eight Key Technical Agreements: Radionuclide Transport (RT) 3.01 and 3.04; Thermal Effects on Flow (TEF) 2.10, 2.11, 2.12, and 2.13; and Total System Performance Assessment and Integration (TSPAI) 3.28 and 3.29, based on information submitted by DOE in 2004.

2.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 10, APPENDIX B: DOE RESPONSE TO AGREEMENTS RT.3.01 and RT.3.04

By letter dated April 12, 2004, DOE submitted a report titled, Technical Basis Document No. 10: Unsaturated Zone Transport (Bechtel SAIC Company, LLC, 2004a). The three appendices of the report contained DOE responses to several key technical issue agreements about unsaturated zone transport.

Appendix B of Bechtel SAIC Company, LLC (2004a) provides the DOE response to Agreements RT.3.01 and RT.3.04. These agreements were reached during a technical exchange meeting between DOE and NRC on radionuclide transport (Reamer, 2000).

2.1 Wording of Agreements

2.1.1 Agreement RT.3.01

"For transport through fault zones below the repository, provide the technical basis for parameters/distributions (consider obtaining additional information, for example, the sampling of wells WT−1 and WT−2), or show the parameters are not important to performance. The DOE will provide a technical basis for the importance to performance of transport through fault zones below the repository. This information will be provided in an update to the AMR Radionuclide Transport Models Under Ambient Conditions available to the NRC in FY 2002. If such transport is found to be important to performance, DOE will provide the technical basis for the parameters/distributions used in FY 2002. The DOE will consider obtaining additional information."

2.1.2 Agreement RT.3.04

"Provide sensitivity studies for the relative importance of the hydrogeological units beneath the repository for transport of radionuclides important to performance. The DOE will provide a sensitivity study to fully evaluate the relative importance of the different units below the repository that could be used to prioritize data collection, testing, and analysis. This study will be documented in an update to the AMR Radionuclide Transport Models Under Ambient Conditions available to the NRC in FY 2002."

2.2 Information Provided for Agreement RT.3.01

The intent of Agreement RT.3.01 was to understand how DOE accounted for the characteristics of fault zone pathways, given that transport parameters were assigned by rock type and did not include any specific consideration of faults except where they were treated explicitly as zones of fracture flow. In the response to RT.3.01, DOE described the assumptions and approximations that were used to conceptualize fault zone pathways in the transport model. Hydrogeological parameters were calibrated using data from the Ghost Dance fault zone. Fault zones were modeled as a collection of fractures in which the hydraulic fracture properties were calibrated within the fault zones, whereas the matrix properties of the fault zone were assumed to be the same as the non-fault matrix of the corresponding rock layer. Fault zone properties were based on the dual-permeability concept, so matrix diffusion was included as a retardation mechanism for radionuclide transport. Sorption was considered in the rock matrix but was not allowed in fractures, including the fractures in fault zones.

Sensitivity analyses were presented in the response to RT.3.01 to demonstrate that fault zones in the model dominated the transport patterns. The importance of fault zones increased with distance traveled. At the top of the water table (i.e., the base of the unsaturated zone), the majority of flow consistently occurred through only a few faults in the DOE model. Even where radionuclides were released into model fractures other than fault zones, the interconnectedness of the fracture system resulted in transport and release of radionuclides from fault zones at the water table. In contrast, transport times in the model were considerably longer where the radionuclides were released from repository matrix blocks rather than fractures. Sensitivity analyses examined the influence of matrix diffusion and sorption in the rock matrix and determined that both processes had a significant impact on breakthrough predictions.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement RT.3.01, and, therefore, NRC staff considers this agreement closed.

2.3 Information Provided for Agreement RT.3.04

In the DOE transport model grid, the unsaturated zone transport pathways below the potential repository include the Topopah Spring welded tuff unit (TSw) and vitric and zeolitic portions of the Calico Hills unit (CHnv and CHnz). The intent of Agreement RT.3.04 was to determine, by sensitivity analyses, the relative importance of these units to radionuclide transport. The sensitivity analyses were conducted using a moderately sorbing radionuclide, neptunium, and a strongly sorbing radionuclide, plutonium. The analyses indicated that the Topopah Spring welded tuff was the most sensitive of the three hydrogeological units in retarding the migration of sorbing radionuclides. This observation was attributed to the fact that there are more fractures in the Topopah Spring welded unit than in the other two units, resulting in a more extensive overall fracture and matrix interface and hence more opportunities for matrix diffusion and sorption onto the minerals in the rock matrix.

Differences in transport patterns and arrival times also were attributed by DOE to differences in stratigraphy between the northern and southern parts of the potential repository. In the northern portion, zeolitic alteration of the Calico Hills tuff is extensive, greatly reducing matrix permeability. In the fractured rock units above the zeolitic portion of the tuff, flow is diverted laterally downdip until reaching a fault zone or more permeable vitric zone that can accommodate vertical flow to the water table.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement RT.3.04, and, therefore, NRC staff considers this agreement closed.

3.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 10, APPENDIX C: DOE RESPONSE TO AGREEMENT TSPAI.3.28

By a letter dated April 12, 2004, U.S. Department of Energy (DOE) submitted Technical Basis Document No. 10 (Bechtel SAIC Company, LLC, 2004a). Appendix C of this report contained DOE's response to Key Technical Issue (KTI) Agreement TSPAI.3.28 concerning independent lines of evidence to increase confidence in the active fracture continuum concept in unsaturated zone transport. This agreement was reached during a technical exchange meeting between NRC and DOE about TSPAI (Reamer, 2001).

Subsequent to this agreement, related NRC concerns were raised in the Integrated Issue Resolution and Status Report (NRC 2002, pp. 3.3.7-5 and pp. 3.3.7-17 to 3.3.7-18). The concerns pointed to a general need for improved transparency of model parameter estimation and numerical implementation of the abstraction transport model, specifically with regard to methods of estimating fracture porosity, the fracture-matrix connection area, fracture aperture values, and fracture spacing.

3.1 Wording of Agreement

The wording of this Agreement TSPAI.3.28 is as follows:

"DOE needs to provide independent lines of evidence to provide additional confidence in the use of the active-fracture continuum concept in the transport model (UZ3.5.1). DOE will provide independent lines of evidence to provide additional confidence in the use of the active fracture continuum concept in the transport model. This will be documented in Radionuclide Transport Models and Submodels AMR (MDL-NBS-HS-000006) expected to be available to NRC in FY 2003."

3.2 Information Provided for Agreement TSPAI.3.28

In support of the active-fracture model, DOE has presented several independent lines of evidence by comparing field data with calculations based on the active-fracture model (BSC, 2004a). These included: (1) a comparison of simulated groundwater ages, using different values of gamma in an active-fracture transport simulation, with groundwater ages estimated from carbon-14 measurements in unsaturated zone porewater and gas samples; (2) a simulation of the expected fraction of active fractures compared with field observations of fracture transport pathways indicated by secondary mineral coatings; and (3) a correspondence between the active-fracture model and fractal flow patterns derived from the spatial distribution of secondary mineralization in fractures. DOE also noted that field data supporting the active-fracture model are relatively sparse, so uncertainties are addressed in the model by using a range of active-fracture model parameters from three infiltration scenarios. In the remainder of the response to TSPAI.3.28, DOE summarizes how the input parameters, including estimates of active-fracture model parameters, were derived for the transport model abstraction. DOE also describes how the active-fracture model, with matrix diffusion, was integrated in DOE's Total System Performance Assessment abstraction. Supporting details for these descriptions are available in several recently released model reports (BSC 2003a-d, BSC 2004b).

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TSPAI.3.28, and, therefore, NRC staff considers this agreement closed.

4.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 10, APPENDIX C: DOE RESPONSE TO AGREEMENT TSPAI.3.29

Appendix C of Technical Basis Document 10: Unsaturated Zone Transport (Bechtel SAIC Company, LLC, 2004a) provides the DOE response to Agreement TSPAI.3.29. This agreement was reached during a technical exchange meeting between DOE and NRC about total system performance assessment and integration (Reamer, 2001a).

Subsequent to the agreements, related NRC concerns were raised in the Integrated Issue Resolution and Status Report (NRC, 2002, p. 3.3.7-5 and pp. 3.3.7-17 through 3.3.7-18). The concerns pointed to a general need for improved transparency of model parameter estimation and numerical implementation of the transport model abstraction, specifically with regard to methods of estimating the following properties: (i) fracture porosity; (ii) fracture-matrix connection area; (iii) fracture aperture values, and whether they have been adjusted to account for the active-fracture concept; and (iv) fracture spacing.

4.1 Wording of Agreement

The wording of this Agreement TSPAI.3.29 is as follows:

"Provide verification that the integration of the active fracture model with matrix diffusion in the transport model is properly implemented in the TSPA abstraction (UZ3.TT.3)[1]. The DOE will provide verification that the integration of the active fracture model with matrix diffusion in the transport model is properly implemented in the TSPA abstraction. This verification will be documented in the Particle Tracking Model and Abstraction of Transport Processes (ANL–NBS–HS–000026) expected to be available to NRC in FY 2003."

4.2 Information Provided for Agreement TSPAI.3.29

The purpose of Agreement TSPAI.3.29 was to clarify how the DOE unsaturated zone radionuclide transport model implements the active-fracture concept. For a given percolation flux, a reduction in the number of actively flowing fractures should result in increased fluid velocity and reduced fracture-matrix interface available for diffusion of radionuclides between flowing fractures and rock matrix.

The DOE response explains that the fraction of active fractures is implicitly considered in the calculation of fluid velocity in the Finite Element Heat and Mass Transfer Code (FEHM) particle-tracking transport model because the flow fields are developed and imported directly into the transport abstraction model. Fluid residence time in the fractures is equal to the volume of water in a computational cell divided by the volumetric flow rate of the fluid. These terms are calculated by calibrated unsaturated zone flow model simulations and imported into the transport model. Therefore, fluid velocities do not need further adjustment in the transport model to account for active fractures because the flow field calculations have already accounted for the active-fracture concept.

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[1]This is an identifier that was used to track the topic during the technical exchange (Reamer, 2001).

Although adjustments to fluid velocity are not needed in the FEHM particle-tracking transport model, it is necessary to adjust both the fracture-matrix interface area and the flowing fracture spacing parameters to be consistent with the active-fracture conceptual model. The DOE response provided a summary of the mathematical approach used to apply these corrections in a manner consistent with the active-fracture approach developed by Liu, et al. (1998).

Verification of the proper implementation of the active fracture conceptualization is provided by comparing results from the FEHM particle-tracking transport model with results from detailed two- and three-dimensional process models that have alternative formulations for evaluating fracture-matrix interaction. Also, DOE provided a comparison with results from the three-dimensional FEHM particle-tracking transport models that use different values for the active-fracture parameter which is of particular relevance to Agreement TSPAI.3.29. This comparison indicates that, for a given percolation flux, reducing the value of the active-fracture parameter (γ) yields longer arrival times for the earliest arriving solute. A decreased value of γ at a given level of effective saturation results in calculation of a greater fraction of actively flowing fractures. Hence, the decreased value of γ results in a greater effective surface area available for diffusion of solute from fractures into the rock matrix and, as would be expected, an increase in the time required for the earliest solutes to arrive at the bottom model boundary.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TSPAI.3.29, and, therefore, NRC staff considers this agreement closed.

5.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 3: SEEPAGE INTO DRIFTS APPENDIX I: DOE RESPONSE TO AGREEMENT TEF.2.10

By letter dated July 28, 2004, DOE submitted a report, Technical Basis Document No. 3: Seepage into Drifts, Appendix I (Bechtel SAIC Company, LLC, 2004c), that contains DOE's response to Agreement TEF.2.10 Additional Information Needed (AIN)–1. Agreement TEF.2.10 originated during the NRC/DOE Technical Exchange and Management Meeting held January 8–9, 2001 (Reamer, 2001b).

5.1 Wording of Agreement

The wording of this Agreement TEF.2.10 is as follows:

"Represent the full variability/uncertainty in the results of the TEF simulations in the abstraction of thermodynamic variables to other models or provide technical basis that a reduced representation is appropriate (considering risk significance)."

The discussion leading to the development of this agreement is provided in NRC (2000). The NRC staff clarified, as follows, their concern regarding representation of the full range of model and parameter uncertainties in DOE's calculated results of thermal effects on flow simulations and informed DOE of additional information needs in Reamer (2002):

"The NRC concern is that the full range of model and parameter uncertainty be incorporated in the TSPA. The multiscale thermohydrologic model (MSTH) is an ensemble of process models linked by abstractions. The MSTH is also linked directly or indirectly to other process models. For example, the NRC is concerned that variability/uncertainty in calibrated properties is treated by using high and low infiltration boundary conditions in addition to the mean in the least squares inversion to obtain calibrated properties. The NRC believes this accounts for variability/uncertainty only in the infiltration boundary condition. As discussed in TEF IRSR, Rev. 03, there are other sources of variability/uncertainty that are not accounted for in this methodology. These include: model uncertainty as seen in results from various alternative conceptual models and data uncertainty in (i) measurement error, bias, and scale-dependence in the saturation, water potential, and pneumatic pressure data used for model parameter calibration, (ii) heterogeneity and spatial variability in thermohydrologic properties, and (iii) variability in model results using the various property sets found to be valid for thermohydrologic modeling and model uncertainty as seen in results from various alternative conceptual models."

"The NRC has reviewed the other thermal effects on flow agreements and believe that the supporting material for satisfying this issue is covered by TEF Agreements 2.08, 2.11, and 2.12. TEF Agreement 2.08 states that DOE will 'provide...results of the outlined items on page 20 of the OI [open item] 7 presentation,' TEF 2.11 states that DOE will 'incorporate uncertainty from all significant sources' in the calibrated properties, and TEF 2.12 states that DOE will 'provide...resolution of issues on page 5 of the OI 8 presentation' on representation of model uncertainty. The NRC staff believes that TEF Agreements 2.08, 2.11, and 2.12 form the basis for determining the full range of possible state variables (temperature, pressure, relative humidity, liquid and vapor flux, etc.). TEF Agreement 2.10 would be satisfied if: (i) the full range of state variables are abstracted for use in TSPA, or (ii) a basis is provided for a reduced representation of model and parameter uncertainty in the TSPA. Documentation of either option should be presented in future AMRs completed prior to License Application."

"Additional Information Needed: DOE should inform the NRC staff how it plans to address this issue and where it will be documented."

5.2 Information Provided for Agreement TEF.2.10

The underlying issue of Agreement TEF.2.10 is the propagation of uncertainty to the performance assessment model or a supporting basis for a reduced representation of uncertainty. The DOE presented its approach for incorporating parameter and model uncertainty and variability in its analyses in Appendix I of Bechtel SAIC Company, LLC (2004c). In Appendix I of BSC (2004c), a summary of sensitivity analyses was provided on the influence of thermal-hydrologic properties and infiltration boundary conditions that indicated to DOE that the full range of uncertainty need not be propagated in the multiscale thermal-hydrologic model calculations of in-drift temperature and relative humidity.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TEF.2.10, and, therefore, NRC staff considers this agreement closed.

6.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 2: UNSATURATED ZONE FLOW APPENDIX C: DOE RESPONSE TO AGREEMENT TEF.2.11

By letter dated May 28, 2004, DOE submitted a report, Technical Basis Document No. 2: Unsaturated Zone Flow (Bechtel SAIC Company, LLC, 2004d), that contains DOE's responses to several key technical issue (KTI) agreements. Appendixes C, E, and F of the report address Agreements TEF.2.11, 2.12, and 2.13.

The DOE response to Agreement TEF.2.11 is provided in Bechtel SAIC Company, LLC (2004d, Appendix C). Agreement TEF.2.11 was reached during the NRC and DOE Technical Exchange and Management Meeting on Thermal Effects on Flow held January 8–9, 2001 (Reamer, 2001b).

6.1 Wording of Agreement

The wording of this Agreement TEF.2.11 is as follows:

"Provide the Calibrated Properties AMR, incorporating uncertainty from all significant sources.

The DOE will provide an updated Calibrated Properties Model AMR (MDL–NBS–HS–000003) Rev. 01 that incorporates uncertainty from all significant sources to the NRC in FY02."

The discussion leading to the development of this agreement is provided in Subissue 2, Open Item 7 (Reamer, 2001b; NRC, 2000). As noted in Subissue 2, Open Item 7, NRC is concerned about the effects of measurement error, bias, and scale-dependence in the saturation, water potential, and pneumatic pressure data used for parameter calibration of ambient hydrological and thermohydrological models (NRC, 2000).

6.2 Information Provided for Agreement TEF.2.11

Agreement TEF.2.11 requested DOE to provide the Calibrated Properties AMR (MDL–NBS–HS–000003) and incorporate uncertainty in the calibrated property set from all significant sources. The NRC staff questioned pneumatic pressure data used for model parameter calibrations.

The DOE addressed the agreement by providing NRC with the referenced document (Bechtel SAIC Company, LLC, 2003e) and by addressing in Bechtel SAIC Company, LLC (2004d, Appendix C) the specific concerns outlined in Agreement TEF.2.11. The DOE addressed the NRC concerns by considering the effects of the following factors on the estimation and uncertainty of the calibrated property sets: (i) uncertainty from spatially heterogeneous properties; (ii) uncertainty in measured data; (iii) propagation of uncertainty in inverse modeling; and (iv) upscaling. The information provided by DOE under these various categories incorporates the information requested by NRC.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TEF.2.11, and, therefore, NRC staff considers this agreement closed.

7.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 2: UNSATURATED ZONE FLOW, APPENDIX E: DOE RESPONSE TO AGREEMENT TEF.2.12

By letter dated May 28, 2004, DOE submitted a report, Technical Basis Document No. 2: Unsaturated Zone Flow (Bechtel SAIC Company, LLC, 2004d), that contains DOE's responses to several key technical issue (KTI) agreements. Appendixes C, E, and F of the report address Agreements TEF.2.11, 2.12, and 2.13.

The DOE response to Agreement TEF.2.12 is provided in Bechtel SAIC Company, LLC (2004d, Appendix E). Agreement TEF.2.12 was reached during the NRC and DOE Technical Exchange and Management Meeting on Thermal Effects on Flow, held January 8–9, 2001 (Reamer, 2001b).

7.1 Wording of Agreement

The wording of Agreement TEF.2.12 is as follows:

"Provide the Unsaturated Zone Flow and Transport PMR, Rev. 00, ICN 02, documenting the resolution of issues on page 5 of the OI 8 presentation. The DOE will provide the Unsaturated Zone Flow and Transport PMR (TDR–NBS–HS–000002) Rev. 00, ICN 02, to the NRC in February 2001. It should be noted, however, that not all of the items listed on page 5 of the DOE's Open Item 8 presentation at this meeting are included in that revision. The DOE will include all the items listed on page 5 of the DOE's Open Item 8 presentation in Revision 02 of the Unsaturated Zone Flow and Transport PMR, scheduled to be available in FY02."

Page 5 of Subissue 2, Open Item 8 (Reamer, 2001b) provides the following direction for closing the agreement.

- To close this open item, DOE needs to evaluate model uncertainty as seen in the results from various alternative conceptual models such as equivalent continuum model, dual permeability model, and active fracture model. The DOE should propagate this uncertainty through the thermohydrological model abstraction.

- Basis for resolution
  The DOE has considered model uncertainty, including:
  — Types of model uncertainty;
  — Flow conceptualization under ambient conditions;
  — Flow conceptualization under thermal conditions;
  — Fracture flow under ambient and thermal conditions;
  — Fracture and matrix interaction model evolution;
  — Discrete fracture description; and
  — Reducing model uncertainty.

7.2 Information Provided for Agreement TEF.2.12

To address model uncertainty as seen in the results of the various alternative conceptual models used to simulate thermal perturbations on the ambient unsaturated zone flow field, DOE considered uncertainty in the various process models used to evaluate thermal effects on flow. Details of the mountain-scale coupled process models are described in Bechtel SAIC Company, LLC (2003e). The DOE indicates (Bechtel SAIC Company, LLC, 2004d) that details of the drift-scale thermal-seepage model are described in Bechtel SAIC Company, LLC (2003f), which was not publicly available at the time of this review. Mountain-scale thermohydrological models described in Bechtel SAIC Company, LLC, (2003e) include: (i) the thermohydrological model; (ii) the mountain-scale thermal-hydrological-chemical model; (iii) the thermal-hydrological-mechanical model; and (iv) the mountain-scale thermohydrological-mechanical model.

The DOE states, "The Drift-Scale Test is developed and calibrated using the Drift-Scale Test data and the thermal-hydrologic seepage model is used for thermal-hydrologic seepage predictions. The drift-scale thermal-hydrologic output is abstracted in Abstraction of Drift Seepage (Bechtel SAIC Company, LLC, 2003f), which develops an abstraction methodology for drift seepage, determines the uncertainty and spatial variability of seepage-relevant parameters, provides lookup tables for seepage into either intact or degraded drifts as a function of these parameters, and evaluates and discusses additional factors affecting seepage, ..."

Staff reviewed DOE's response relative to the list of considerations contained in the basis of resolution of the agreement (page 5, Subissue 2, Open Item 8). These considerations requested DOE discuss uncertainty in its thermohydrological models from the perspective of: (i) types of model uncertainty; (ii) flow conceptualization under ambient conditions; (iii) flow conceptualization under thermal conditions; (iv) fracture flow under ambient and thermal conditions; (v) fracture and matrix interaction model evolution; (vi) discrete fracture description; and (vii) reducing model uncertainty. The DOE was responsive to the questions raised by NRC in Agreement TEF.2.12 by providing detailed information about the approach taken to address each item identified in Reamer (2001b).

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TEF.2.12, and, therefore, NRC staff considers this agreement closed.

8.0 REVIEW OF TECHNICAL BASIS DOCUMENT NO. 2: UNSATURATED ZONE FLOW, APPENDIX F: DOE RESPONSE TO AGREEMENT TEF. 2.13

By letter dated May 28, 2004, DOE submitted a report, Technical Basis Document No. 2: Unsaturated Zone Flow (Bechtel SAIC Company, LLC, 2004d), that contains DOE's responses to several key technical issue (KTI) agreements. Appendixes C, E, and F of the report address Agreements TEF.2.11, 2.12, and 2.13.

The DOE response to Agreement TEF.2.13 is provided in Bechtel SAIC Company, LLC (2004d), Appendix F). Agreement TEF.2.13 was reached during the NRC and DOE Technical Exchange and Management Meeting on Thermal Effects on Flow held January 8–9, 2001 (Reamer, 2001b).

8.1 Wording of Agreement

The wording of the Agreement TEF.2.13 is as follows:

"Provide the Conceptual and Numerical Models for Unsaturated Zone Flow and Transport AMR, Rev. 01 and the Analysis of Hydrologic Properties Data AMR, Rev. 01. The DOE will provide updates to the Conceptual and Numerical Models for UZ Flow and Transport (MDL–NBS–HS–000005) Rev. 01 and the Analysis of Hydrologic Properties Data (ANL–NB–HS–000002) Rev. 01 AMRs to the NRC. Scheduled availability is FY02."

The discussion leading to the development of the original agreement is provided in Subissue 2, Open Item 8 (Reamer, 2001b; NRC, 2000). The DOE submitted an initial response to the agreement in Ziegler (2003). Following its review of the initial DOE response, NRC requested additional information from DOE to complete review of the agreement (Schlueter, 2004). The wording of the additional information need is as follows:

"DOE may choose to complete Agreement TEF.2.13 by either providing: (1) additional technical information as discussed in Section 4.1 of the attachment including a technical basis demonstrating that: (i) preferential flow in fractures is not masked by the volume-averaging of the coarse grid cell in continuum models; (ii) appropriate heterogeneity representing fractures are appropriate for unsaturated flow in fractures; (iii) the van Genuchten relations and parameters are appropriate for unsaturated flow in fractures; and (iv) the model uncertainty noted above have been addressed in all appropriate hydrologic and thermohydrologic process and abstraction models; or (2) additional risk information as discussed in Section 4.3 of the attachment. With regards to the latter option, the disposition of Agreement TEF.2.13 can be determined after DOE adequately address NRC's concerns with its approach to resolving agreements via risk arguments and sensitivity analyses as discussed in the January 27, 2003, risk letter."

8.2 Information Provided for Agreement TEF.2.13

In Appendix F of Bechtel SAIC Company, LLC (2004d), DOE provides additional technical information to complete Agreement TEF.2.13, rather than relying on low risk arguments to complete the agreement. The DOE addressed the NRC concerns by providing information about: (i) modeling with refined grids with different representations of heterogeneity and noting the practical difficulties in implementing a true discrete fracture model; (ii) parameter heterogeneity for representing fracture flow and subgrid modeling to support development of parameters for larger scale models; (iii) preferential flow, the van Genuchten relations for fractures, and the active fracture concept; and (iv) uncertainties in all relevant ambient and thermal flow models. The DOE provided relevant information and was responsive to the NRC concerns raised in the agreement.

Based on review of the information provided by DOE, the NRC staff concluded that DOE has provided information responsive to Agreement TEF. 2.13, and, therefore, NRC staff considers this agreement closed.

9.0 SUMMARY

The NRC staff reviewed the information provided by DOE in Bechtel SAIC Company, LLC (2004a, 2004c, and 2004d) for Agreements RT.3.01, RT.3.04, TSPAI.3.28, TSPAI.3.29, TEF.2.10, TEF.2.11, TEF.2.12, and TEF.2.13. Based on this review, the NRC staff concluded that DOE provided information responsive to the intent of these agreements, and, therefore, NRC staff considers these agreements closed.

10.0 REFERENCES

Bechtel SAIC Company, LLC. “Technical Basis Document No. 10: Unsaturated Zone Transport.” Las Vegas, Nevada: Bechtel SAIC Company. 2004a.

Bechtel SAIC Company, LLC. “Particle Tracking Model and Abstraction of Transport Processes.” MDL-NBS-HS-000020 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. 2004b.

Bechtel SAIC Company, LLC . “Technical Basis Document No. 3: Seepage into Drifts.” Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2004c.

Bechtel SAIC Company, LLC . “Technical Basis Document No. 2: Unsaturated Zone Flow.” Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2004d.

Bechtel SAIC Company, LLC. “UZ Flow Models and Submodels.” MDL-NBS-HS-000006 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. 2003a.

Bechtel SAIC Company, LLC. “Radionuclide Transport Models Under Ambient Conditions.” MDL-NBS-HS-000008 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. 2003b.

Bechtel SAIC Company, LLC. “Calibrated Properties Model.” MDL-NBS-HS-000003 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. 2003c.

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Bechtel SAIC Company, LLC. “Drift-Scale Coupled Processes (DST and TH Seepage) Models.” MDL–NBS–HS–000015. Rev. 00C. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003f.

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NRC. “Risk Insights Baseline Report.” -Washington, DC: U.S. Nuclear Regulatory Commission. April, 2004a.

NRC. “Integrated Issue Resolution Status Report.” NUREG-1762, Rev 1. Washington, DC: U.S. Nuclear Regulatory Commission. April, 2004b.

NRC. “Final Staff Response to March 19, 2003, Staff Requirements Memorandum on the Waste Arena Briefing.” ML030840056. Washington, DC: NRC. June 2003.

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